TA 683
.A63

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TA 683
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STANDARD REINFORCED CONCRETE CHARTS
FOR
COLUMNS, BEAMS AND SLABS

BASED ON

JOINT COMMITTEE RECOMMENDATIONS

1913

Hiram Bertrand Andrews.

TAG83
.A63

$5.00

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APR 2 1915

15-7347

STANDARD
REINFORCED CONCRETE CHARTS
5 SHEETS
No. 1

SAFE LOADS ON REINFORCED CONCRETE COLUMNS

BASED ON JOINT COMMITTEE RECOMMENDATIONS
1913 REPORT

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166 DEVONSHIRE ST. BOSTON, MASS.

ASSUMPTIONS VERIFIED BY [illegible]
CALCULATIONS VERIFIED BY [illegible]

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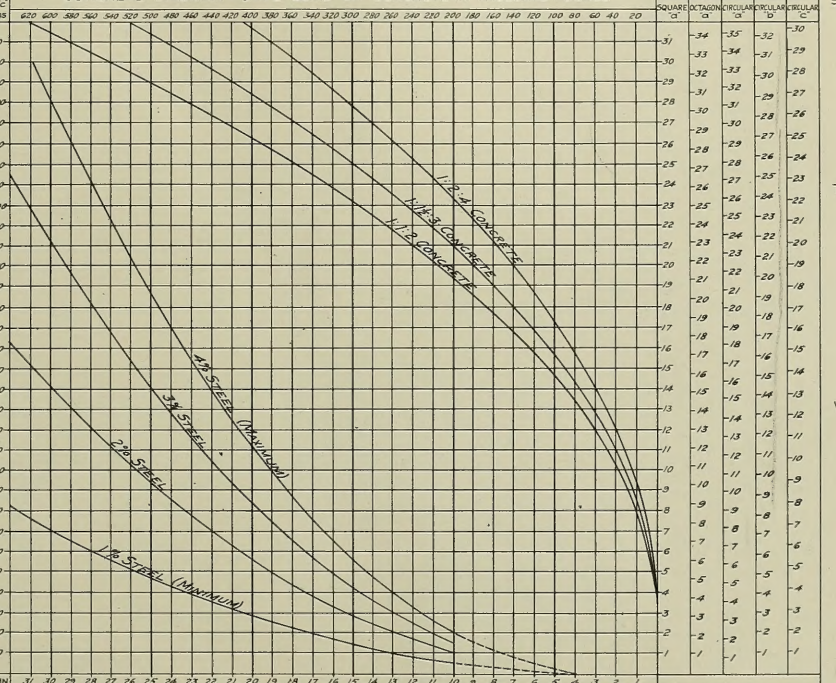
Note: The safe loads on steel given in these columns are corrected for the area of concrete replaced by steel. These figures are for a 1:2:4 concrete. Add 4% to them if a 1:1½:3 or 1:2:4 concrete is used.



NUMBER AND SIZE OF RODS AND SECTIONAL AREA IN SQUARE INCHES

Number	5/8"		3/4"		7/8"		1"		1⅛"		1¼"		1⅜"	
	○	□	○	□	○	□	○	□	○	□	○	□	○	□
4	1.23	1.56	1.77	2.25	2.41	3.06	3.14	4.00	3.98	5.06	4.91	6.25	5.94	7.56
6	1.84	2.34	2.65	3.38	3.61	4.59	4.71	6.00	5.96	7.59	7.36	9.38	8.91	11.34
8	2.45	3.12	3.53	4.50	4.81	6.12	6.28	8.00	7.95	10.12	9.82	12.50	11.88	15.12
10	3.07	3.91	4.42	5.62	6.01	7.66	7.85	10.00	9.94	12.66	12.27	15.63	14.85	18.91
12	3.68	4.69	5.30	6.75	7.22	9.19	9.42	12.00	11.93	15.19	14.73	18.75	17.82	22.69
14	4.30	5.47	6.18	7.88	8.42	10.72	11.00	14.00	13.92	17.72	17.18	21.88	20.79	26.47
16	4.91	6.25	7.07	9.00	9.62	12.25	12.57	16.00	15.90	20.25	19.63	25.00	23.76	30.25

HOOPED COLUMN REINFORCEMENT (1% OF ENCLOSED CONCRETE)

DIAMETER OF ENCLOSED CONCRETE	7"	8"	9"	10"	11"	12"	14"	16"	18"	20"	22"	24"	26"	28"
SIZE OF HOOPING	7 Wire	7 Wire	6 Wire	¼ Dia.	¼ Dia.	¼ Dia.	⅜ Dia.	⅜ Dia.	⅜ Dia.	⅜ Dia.	½ Dia.	½ Dia.	½ Dia.	½ Dia.
MAXIMUM PITCH	1¼"	1¼"	1¼"	1⅜"	1⅜"	1⅜"	2"	2½"	2½"	2½"	2⅝"	2½"	2½"	2½"
LENGTH OF HOOPING IN 1 FT. IN HEIGHT	17'-7"	20'-1"	22'-8"	21'-0"	21'-3"	23'-3"	22'-0"	20'-1"	23'-10"	29'-7"	27'-9"	31'-10"	36'-4"	35'-3"

COLUMNS

Standard Notation:—
(Note: Allow 1½" for fireproofing)
A = Total Net Area (Exclusive of fireproofing)
A_s = Area of Longitudinal Steel
A_c = Area of Concrete
P = Total Safe Load
f_s = Compressive Unit Stress in Steel
f_c = Compressive Unit Stress in Concrete
E_s = Modulus of Elasticity of Steel
E_c = Modulus of Elasticity of Concrete
$n = \frac{E_s}{E_c}$
p = Steel Ratio

Total Safe Load,
$P = f_c A [1 + (n-1)p]$

'a' Columns with longitudinal reinforcement only not less than 1% and not more than 4%.
'b' Columns with reinforcement of bands, hoops or spirals of not less than 1% of volume of concrete enclosed. The clear spacing of hooping shall not be more than one-sixth diameter of enclosed column, preferably not more than one-tenth, and in no case over 2½".
'c' Columns with not less than 1% and not more than 4% of longitudinal reinforcement, and with bands, hoops or spirals as previously described.

Working Stresses (In Lbs. per Sq. In.)

Working Stress = 22½% Ultimate

	Ultimate 'a'	Working 'b'	Working 'c'
1:1:2 Concrete	3300	742	880	1063
1:1½:3 Concrete	2800	622	746	902
1:2:4 Concrete	2200	489	587	707

These values are for a coarse aggregate of granite or trap rock, and are used in diagram. If gravel, hard lime stone or hard sand stone are used deduct 10% from safe load and if soft lime stone or soft sand stone is used deduct 35% from safe load. They are also based upon a sand equal to standard sand. If sand is inferior proportion of cement must be increased.
Allow compression on footing blocks, having a top area of not less than that of the column.
For 1:1:2 Concrete 3300 + 32½ = 1012 lbs. per sq. in.
1:1½:3 Concrete 2800 + 32½ = 910 lbs. per sq. in.
1:2:4 Concrete 2200 + 32½ = 715 lbs. per sq. in.
The values for types 'a' and 'b' are for columns whose length is not over 12 diameters, and for type 'c' whose length is not over 8 diameters.

Steel:

	n	Compression in Steel 'a'	'b'
For 1:1:2 Concrete	n=10	7420	9800	10630
For 1:1½:3 Concrete	n=12	7464	9952	10824
For 1:2:4 Concrete	n=15	7335	8805	10605

Example of use of Diagram.
To find safe load for 20 circular column, type 'c', 1:1½:3 concrete, 3% longitudinal steel:—
From figure 20 in extreme R.H. space follow bar line to 1:1½:3 curve, then vertically to 202,000 for concrete. From figure 20 in space for circular column at bottom follow vertically to 3% then to left to 68,000 for steel. 68,000 × 4% = 2,700
202,000 + 68,000 + 2,700 = 272,700

STANDARD
REINFORCED CONCRETE CHARTS
5 SHEETS No. 2

SAFE LOADS ON REINFORCED CONCRETE BEAMS

BASED ON JOINT COMMITTEE RECOMMENDATIONS
1913 REPORT

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JAN. 1914.

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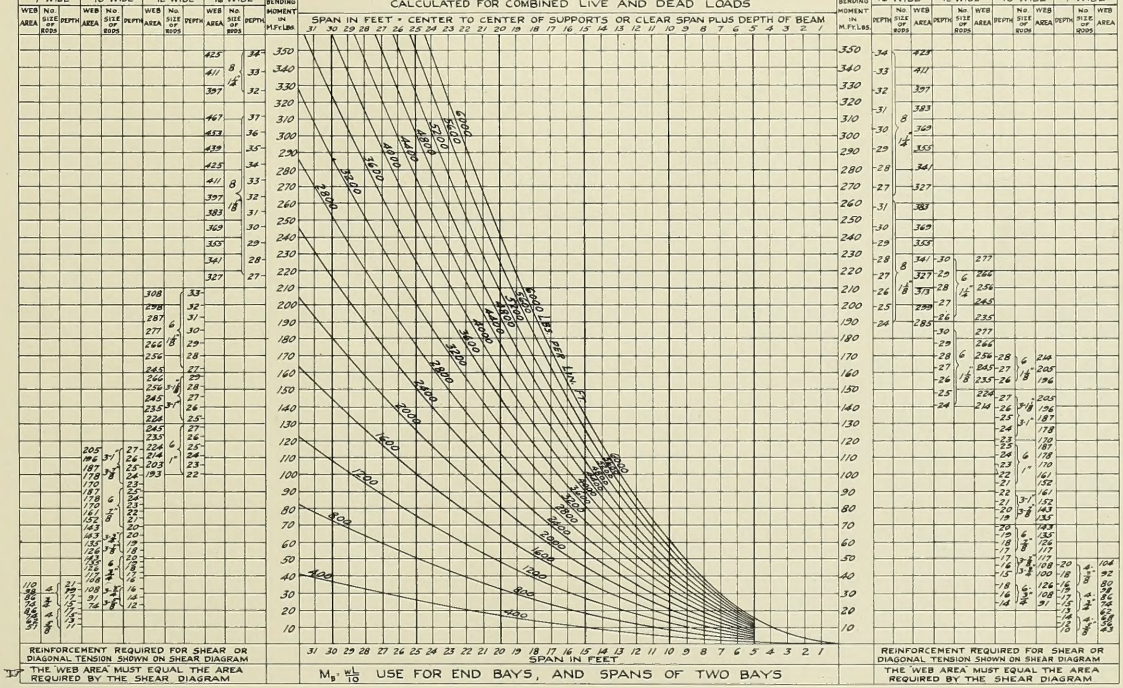
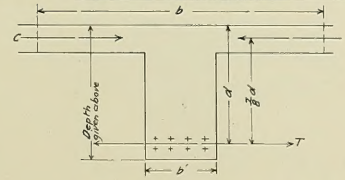

USE WITH 1:2:4 CONCRETE
7" WIDE
10" WIDE
12" WIDE
14" WIDE
WEB AREA
No. SIZE OF RODS
DEPTH
BENDING MOMENT IN M.FT.LBS.
MAXIMUM BENDING MOMENT FOR UNIFORM LOADS
CALCULATED FOR COMBINED LIVE AND DEAD LOADS
SPAN IN FEET = CENTER TO CENTER OF SUPPORTS OR CLEAR SPAN PLUS DEPTH OF BEAM
SPAN IN FEET
USE WITH 1:1½:3 CONCRETE
16" WIDE
12" WIDE
10" WIDE
7" WIDE
REINFORCEMENT REQUIRED FOR SHEAR OR DIAGONAL TENSION SHOWN ON SHEAR DIAGRAM
THE WEB AREA MUST EQUAL THE AREA REQUIRED BY THE SHEAR DIAGRAM
Important
$M_B = \frac{1}{10}$ USE FOR END BAYS, AND SPANS OF TWO BAYS



T BEAMS

STANDARD NOTATION

f_s = Tensile Unit stress in steel
f_c = Tensile Unit stress in concrete
M = Moment of resistance
A = Steel area'd
b' = Width of stem
d = Depth of beam to center of steel
p = Steel ratio (not percentage) to b'd
$\frac{7}{8}d$ = Lever arm (closely approximate)
E_s = Modulus of Elasticity of steel
E_c = Modulus of Elasticity of concrete
$n = \frac{E_s}{E_c}$

FORMULAE

Steel ratio for balanced reinforcement
$p = \frac{1}{2}\frac{f_c}{f_s}\left(\frac{1}{\frac{f_s}{nf_c}+1}\right)$ rectangular beams

Moment of resistance
$M = \frac{7}{8}df_sA$

For T-Beams 1:2:4 concrete $p = \frac{1}{45} = 2.13\%$ (Approx.)
For T-Beams 1:1½:3 concrete $p = \frac{1}{59} = 2.70\%$ "
for balanced reinforcement, percentage of steel being limited by compression in web of beam adjacent to support. Slab must be thickened if necessary to provide sufficient area in compression.

SHEAR, BOND AND WEB REINFORCEMENT

Vertical Web reinforcement
$P = \frac{V_2}{\frac{7}{8}d}$

Web reinforcement inclined at 45% (not bent-up bars)
$P = 0.7\frac{V_2}{\frac{7}{8}d}$

in which P = stress in reinforcing member in one vertical or inclined plane, V = amount of total shear assumed as carried by the reinforcement, and s = horizontal spacing of the reinforcing members.

STANDARD
REINFORCED CONCRETE CHARTS
5 SHEETS No. 3

JAN. 1914

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SAFE LOADS ON REINFORCED CONCRETE BEAMS

BASED ON JOINT COMMITTEE RECOMMENDATIONS
1913 REPORT

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H.B. ANDREWS, MEM. AM. SOC. C.E.
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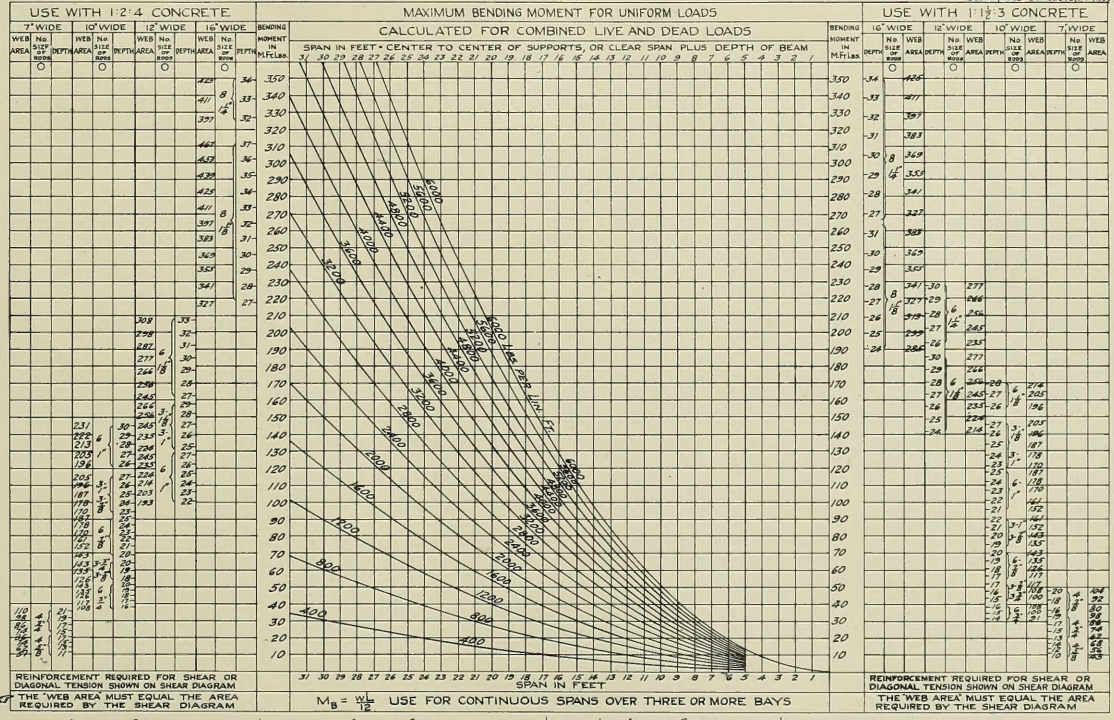
USE WITH 1:2:4 CONCRETE.

MAXIMUM BENDING MOMENT FOR UNIFORM LOADS
CALCULATED FOR COMBINED LIVE AND DEAD LOADS

USE WITH 1:1½:3 CONCRETE.

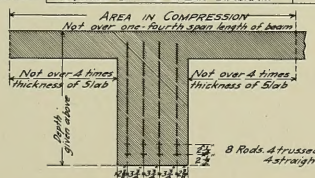


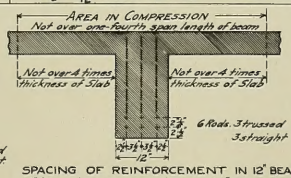
REINFORCEMENT REQUIRED FOR SHEAR OR DIAGONAL TENSION SHOWN ON SHEAR DIAGRAM

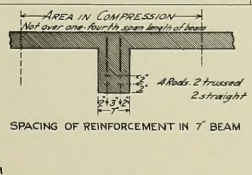
THE "WEB AREA" MUST EQUAL THE AREA REQUIRED BY THE SHEAR DIAGRAM

$M_B = \frac{WL}{12}$ USE FOR CONTINUOUS SPANS OVER THREE OR MORE BAYS

Important


AREA IN COMPRESSION
Not over one-fourth span length of beam
Not over 4 times thickness of Slab
Not over 4 times thickness of Slab
Bends over
8 Rods. 4 trussed 4 straight
SPACING OF REINFORCEMENT IN 16" BEAM


AREA IN COMPRESSION
Not over one-fourth span length of beam
Not over 4 times thickness of Slab
Not over 4 times thickness of Slab
6 Rods. 3 trussed 3 straight
SPACING OF REINFORCEMENT IN 12" BEAM
10 Beam has 6 rods, but spaced 3 on centres.


AREA IN COMPRESSION
Not over one-fourth span length of beam
4 Rods. 2 trussed 2 straight
SPACING OF REINFORCEMENT IN 7" BEAM

SECTIONAL AREA AND WEIGHT OF REINFORCEMENT

	¼ DIA.		⅜ DIA.		½ DIA.		1" DIA.		1⅛ DIA.		1¼ DIA.	
	AREA	WT	AREA	WT	AREA	WT	AREA	WT	AREA	WT	AREA	WT
	"	LBS	"	LBS	"	LBS	"	LBS	"	LBS	"	LBS
1 Rod	.31	1.04	.44	1.50	.60	2.04	.79	2.67	.99	3.38	1.23	4.17
2 "	.61	2.09	.88	3.00	1.20	4.09	1.57	5.34	1.99	6.76	2.45	8.35
3 "	.92	3.13	1.33	4.51	1.80	6.13	2.35	8.01	2.98	10.14	3.68	12.52
4 "	1.23	4.17	1.77	6.01	2.40	8.18	3.14	10.68	3.98	13.52	4.91	16.69
6 "	1.84	6.26	2.65	9.01	3.61	12.26	4.71	16.03	5.96	20.27	7.36	25.04
8 "	2.45	8.34	3.53	12.01	4.81	16.35	6.28	21.36	7.95	27.03	9.82	33.38

STANDARD
REINFORCED CONCRETE CHART
5 SHEETS No.4

JAN. 1914.

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SAFE LOADS ON REINFORCED CONCRETE SLABS

BASED ON JOINT COMMITTEE RECOMMENDATIONS
1913 REPORT

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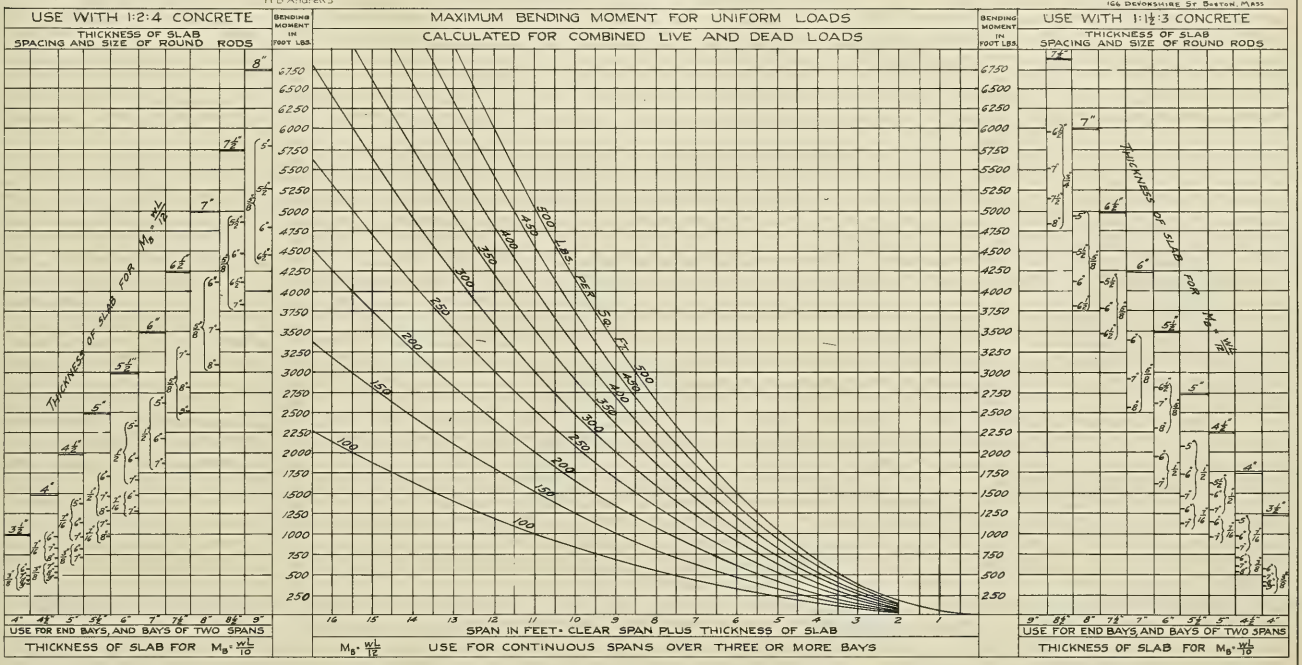
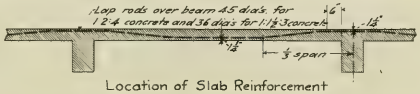

USE WITH 1:2:4 CONCRETE
THICKNESS OF SLAB
SPACING AND SIZE OF ROUND RODS
BENDING MOMENT IN FOOT LBS.
MAXIMUM BENDING MOMENT FOR UNIFORM LOADS
CALCULATED FOR COMBINED LIVE AND DEAD LOADS
300 LBS. PER SQ. FT.
450
400
350
300
250
200
150
100
USE WITH 1:1½:3 CONCRETE
THICKNESS OF SLAB
SPACING AND SIZE OF ROUND RODS
THICKNESS OF SLAB FOR M_B = W/12
SPAN IN FEET - CLEAR SPAN PLUS THICKNESS OF SLAB
USE FOR END BAYS, AND BAYS OF TWO SPANS
THICKNESS OF SLAB FOR M_B = W/10
M_B = W/12 USE FOR CONTINUOUS SPANS OVER THREE OR MORE BAYS

SPACING AND SECTIONAL AREA OF RODS FOR 12" WIDTH

SIZE		SPACING AND SECTIONAL AREA												
		4"	4½"	5"	5½"	6"	6½"	7"	7½"	8"	8½"	9"	9½"	10"	10½"	11"	11½"	12"
5/16"	○	.230	.205	.184	.167	.153	.141	.131	.123	.115	.108	.102	.097	.092	.088	.084	.080	.077
	□	.291	.260	.234	.213	.195	.180	.167	.156	.146	.137	.130	.123	.117	.111	.106	.102	.098
3/8"	○	.331	.294	.265	.241	.221	.204	.189	.177	.166	.156	.147	.139	.132	.126	.120	.115	.110
	□	.422	.375	.337	.307	.281	.260	.241	.225	.211	.198	.187	.175	.169	.161	.154	.147	.141
7/16"	○	.451	.401	.361	.328	.301	.277	.258	.240	.225	.212	.200	.190	.180	.173	.164	.156	.150
	□	.574	.510	.459	.418	.383	.353	.328	.306	.287	.270	.255	.241	.230	.219	.209	.199	.191
½"	○	.589	.523	.471	.428	.393	.362	.336	.314	.294	.277	.262	.248	.236	.225	.214	.204	.196
	□	.750	.667	.600	.545	.500	.462	.429	.400	.375	.353	.333	.316	.300	.286	.273	.261	.250
9/16"	○	.745	.663	.596	.542	.497	.459	.426	.398	.373	.351	.331	.314	.298	.284	.271	.259	.248
	□	.949	.844	.759	.690	.633	.584	.542	.506	.474	.447	.422	.400	.380	.362	.345	.330	.316
5/8"	○	.920	.818	.736	.669	.614	.566	.526	.491	.460	.433	.409	.387	.368	.351	.335	.320	.307
	□	1.172	1.042	.937	.852	.781	.721	.670	.625	.586	.551	.521	.493	.469	.446	.426	.408	.391
11/16"	○	1.116	.990	.891	.810	.742	.685	.636	.594	.557	.524	.495	.469	.445	.424	.405	.387	.371
	□	1.418	1.261	1.134	1.031	.945	.873	.810	.756	.709	.668	.630	.597	.567	.540	.516	.494	.473
¾"	○	1.325	1.178	1.060	.964	.884	.816	.757	.707	.663	.624	.589	.558	.530	.505	.482	.461	.442
	□	1.687	1.500	1.350	1.227	1.125	1.038	.964	.900	.844	.794	.750	.711	.675	.643	.613	.586	.562



Location of Slab Reinforcement

Slab reinforcement to be accurately spaced and firmly held in position.
These diagrams are planned to provide same reinforcement for end bays as for continuous bays, but the concrete slabs for end bays are made thicker as shown on diagrain at bottom of spaces

COMPRESSIVE STRESS IN CONCRETE

Not to be exceeded in slabs or beams.
For 1:2:4 concrete $f_c = (2200 \times .325) = 715$ Lbs. per sq. in.
For 1:1½:3 concrete $f_c = (2800 \times .325) = 910$ Lbs. per sq. in.

FORMULAE:-

$$p = \frac{1}{2n}\left(\sqrt{\frac{2n}{1.15}+1}\right)$$

$M_B = \frac{7}{8} d f_s A_s$

For balanced reinforcement { For 1:2:4 concrete $p = \frac{1}{112} = .89$ of one per cent.
For 1:1½:3 concrete $p = \frac{1}{88} = 1.14$ of one per cent.

These values are for an aggregate of granite or trap rock
For gravel, hard lime stone and hard sand stone deduct 10% From compressive stress, and for soft lime stone and soft sand stone deduct 20%, making corresponding deductions for maximum steel.
They are also based upon a sand equal to standard sand.
If sand is inferior proportion of cement must be increased

TENSILE STRESS IN STEEL
16,000 Lbs. per sq. in.

C.B.D.H.

STANDARD
REINFORCED CONCRETE CHARTS
5 SHEETS No. 5

ASSUMPTIONS VERIFIED BY
CALCULATIONS VERIFIED BY

SHEAR IN REINFORCED CONCRETE BEAMS

BASED ON JOINT COMMITTEE RECOMMENDATIONS
1913 REPORT

JAN. 1914

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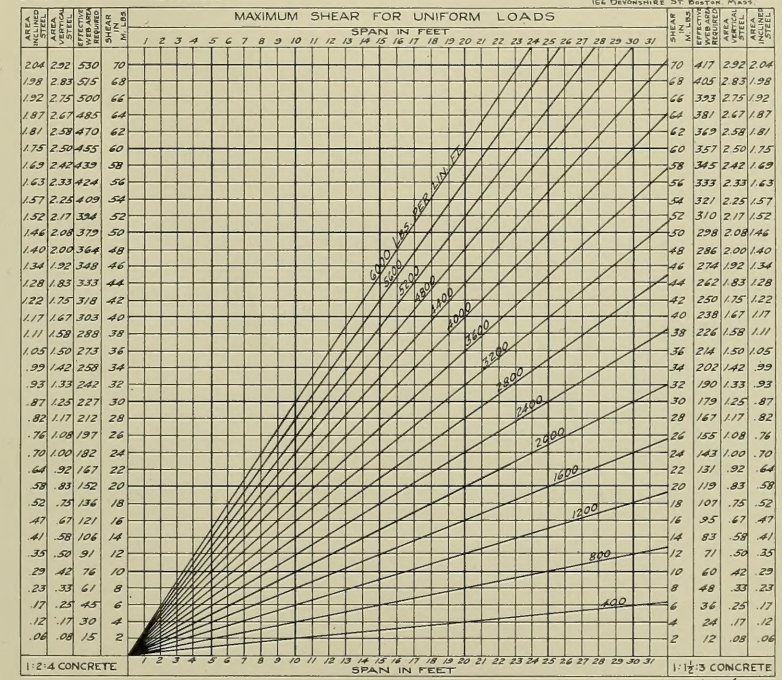


SHEAR AND DIAGONAL TENSION.

UNIT STRESS IN CONCRETE

(a) For beams with horizontal bars only, no web reinforcement.
1:1:2 Concrete 3300 × .02 = 66 lbs per sq. in.
1:1½:3 " 2800 × .02 = 56 " " " "
1:2:4 " 2200 × .02 = 44 " " " "

* (b) For beams thoroughly reinforced with web reinforcement to take care of two-thirds of Vertical Shear.
1:1:2 Concrete 3300 × .06 = 198 lbs. per sq. in.
1:1½:3 " 2800 × .06 = 168 " " " "
1:2:4 " 2200 × .06 = 132 " " " "

(c) For beams in which one-half of bars are trussed over supports if properly designed.
1:1:2 Concrete 3300 × .03 = 99 lbs. per sq. in.
1:1½:3 " 2800 × .03 = 84 " " " "
1:2:4 " 2200 × .03 = 66 " " " "

(d) Punching shear, referring especially to bases of columns, same values as for (b).

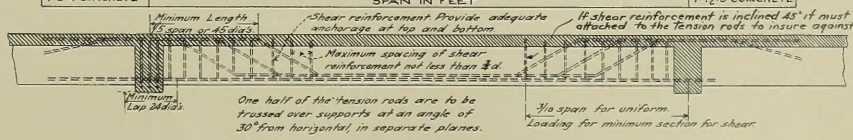
UNIT STRESS FOR BOND

Assuming 16000 lbs. per sq. in.
Working tensile stress in plain steel bars
1:1:2 Concrete 3300 × .04 = 132 × 30 Dia's.
1:1½:3 " 2800 × .04 = 112 = 36 "
1:2:4 " 2200 × .04 = 88 = 45 "

NOTE:-

The area of vertical steel required for stirrups is that quoted in the table for a section of beam equal in length to $\frac{7}{8}d$. If the stirrups are inclined at an angle of 45°, .7 of the area of vertical steel may be used. The longitudinal spacing of stirrups should not be over $\frac{7}{8}d$.

* It is recommended that beams shall be designed with web reinforcement. The diagram is plotted using unit stresses given under (b)


Minimum Length ½ span or 45 dia's.
Shear reinforcement Provide adequate anchorage at top and bottom
If shear reinforcement is inclined 45° it must be rigidly attached to the tension rods to insure against slip.
Maximum spacing of shear reinforcement not less than ⅞d.
Minimum Lap 24 dia's.
One half of the tension rods are to be trussed over supports at an angle of 30° from horizontal, in separate planes.
3/10 span for uniform Loading for minimum section for shear.

TYPICAL REINFORCED CONCRETE BEAM

LIBRARY OF CONGRESS
0 021 622 358 5

Conservation Resources
Lig-Free® Type I

LIBRARY OF CONGRESS
0 021 622 358 5

Conservation Resources
Lig-Free® Type I
Ph 8.5, Buffered